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Cycling and Female Sexual and Urinary Function: Results From a Large, Multinational, Cross-Sectional Study

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ABSTRACT

Background: Bicycle riding has become an increasingly popular mode of transportation and exercise, especially among women, and previous studies have demonstrated a relationship between cycling and sexual dysfunction, albeit using non-validated questionnaires.

Aim: We aimed to explore the relationship between cycling and sexual and urinary dysfunction.

Methods: Cyclists were recruited to complete a survey through Facebook advertisements and outreach to sporting clubs across 5 English-speaking countries. Swimmers and runners were recruited as a comparison group.

Outcomes: Participants were queried using validated questionnaires, including the Female Sexual Function Index, the American Urological Association Symptom Index, and non-validated questions about history of urinary tract infections (UTIs), genital numbness, and genital saddle sores (all self-reported).

Results: 3,118 (53.3%) Women completed the survey, comprising 1,053 (34%) non-cyclists, 1,656 (53%) low-intensity cyclists, and 409 (13%) high-intensity cyclists. After adjusting for age, body mass index, hypertension, diabetes, ischemic heart disease, tobacco use, race, marital status, urinary symptoms, and sexual activity, high-intensity cyclists had lower odds of self-reported sexual dysfunction compared to non-cyclists (adjusted odds ratio [aOR] 0.7, $P = .02$). There were no statistically significant differences in urinary symptoms across groups. Compared to non-cyclists, both low- and high-intensity cyclists had higher odds of reporting a previous UTI (aOR 1.4, $P < .001$, and aOR 1.4, $P = .009$, respectively), genital numbness (odds ratio [OR] 6.5, $P < .001$, and OR 9.1, $P < .001$, respectively), and saddle sores (OR 6.3, $P < .001$, and OR 22.7, $P < .001$, respectively).

Clinical Translation: Women cyclists were more likely to report other genitourinary conditions, including UTIs, genital numbness, and saddle sores.

Conclusions: This is the largest study comparing cyclists to other athletes with respect to sexual and urinary function. The study is limited by its cross-sectional design and sampling methods. We found that women cyclists were no more likely to report sexual dysfunction or urinary symptoms than swimmers or runners. **Gaither TW, Awad MA, Murphy GP, et al. Cycling and Female Sexual and Urinary Function: Results From a Large, Multinational, Cross-Sectional Study. J Sex Med 2018;15:510–518.**

Key Words: Bicycle; Lower Urinary Tract Symptoms; Saddle Sores; Sexual Dysfunction; Urinary Tract Infection

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INTRODUCTION

Bicycle riding has become an increasingly popular mode of transportation and exercise, especially among women.[1] The American Bicyclist Study recently found that women comprise approximately half of cyclists in the United States today, an 8% increase from 2011−2012.[2] The health benefits from cycling include reduced all-cause and cancer mortality, and decreased morbidity due to cardiovascular and obesity-related diseases.[3] While the net effects of cycling on health are overwhelmingly positive, prolonged contact between perineal soft-tissue structures and a narrow, firm bicycle saddle has been hypothesized to have deleterious effects in women and men.[4,5] Other anatomical considerations include pudendal nerve stretch around Alcock canal or compression of the dorsal nerve of the clitoris with prolonged cycling positioning.[6]

Female sexual dysfunction secondary to cycling may occur because of prolonged perineal pressure and micro-trauma that disrupts normal neurological function.[7] Such perineal pressures may also cause chronic labial swelling from lymphatic obstruction.[8] The majority of studies linking cycling to sexual dysfunction are small case series.[1,5] LaSalle et al[9] related the lifetime number of cycling miles to hematuria, dysuria, and perineal numbness. In another small study, women cyclists reported greater difficulty achieving orgasm, difficulty urinating, and chronic perineal pain.[10] However, both studies lacked use of validated measures for urinary and sexual health, and were limited by small sample sizes. In a large, multinational, comparative cross-sectional study, we aimed to explore the relationship between cycling and sexual and urinary dysfunction. We hypothesized that cycling negatively impacts sexual and urinary function.

MATERIALS AND METHODS

Recruitment

Cyclists were recruited to complete an anonymous survey. The survey was pre-tested for readability before recruitment. We recruited through a Facebook advertisement and online outreach to English-speaking sporting clubs in the United States, Canada, United Kingdom, Australia, and New Zealand. Due to their similar healthy lifestyle, swimmers and runners were chosen as comparison groups, and defined as non-cyclists.[11] The study was approved by the institutional review board at University of California, San Francisco. 5 Randomly selected participants received a $100 gift card.

Facebook Advertisement

As of July 2016, with more than 1 billion daily active users, Facebook is one of the leading social networks worldwide.[12] Due to its relatively low per-participant cost and ability to have a targeted audience, Facebook advertisements have been a successful recruitment tool in health-related research studies.[13,14] Our target audiences were adults (18 years and older) residing in the United States, Canada, United Kingdom, Australia, or New Zealand. We used multiple key words related to cycling, swimming, and running to specify our audience (eg, "racing bicycle," "road bike cycling," "jogging," "medley swimming," "open water swimming," "pro cycling," "freestyle swimming," "marathons," "mountain biking"). We recruited participants based on images of cycling, swimming, and running (exposures) but avoided advertising based on our primary outcomes, urinary or sexual dysfunction, to reduce the potential for selection bias. A sample advertisement is found in Appendix A.

Sporting Clubs Outreach

We queried major cycling, swimming, and running organizational websites in the United States, Canada, United Kingdom, Australia, and New Zealand. We identified sporting club leadership and requested our survey be sent out to club membership list-serves. A sample letter is found in Appendix B. Both Facebook advertising and club outreach campaigns started on April 2016 and ended on December 2016.

Cycling, Swimming, and Running Ascertainment

On the survey, participants were queried about cycling, swimming, and running exposures, as well as the intensity of performance. Cyclists were divided into 2 groups: high and low intensity. High-intensity cyclists were defined as respondents who cycled for more than 2 years, more than 3 times/wk, and a daily average of more than 25 miles. Low-intensity cyclists were respondents who cycled but did not meet criteria for high-intensity cyclists. We also divided cyclists by quintile of lifetime miles ridden to further evaluate duration of exposure. Non-cyclists were defined as those who swam and/or ran but did not regularly cycle.

Cycling characteristics were also queried. We collected bike type (mountain, road, hybrid, electric, folding, recumbent, other), saddle type (wide, unpadded; long, narrow, with minimal padding; narrow, medium padded; wide, heavily padded; wide, well-padded cruiser; noseless; dual pad), frequency of wearing padded shorts (always, mostly, sometimes, rarely, never), percent time standing while cycling (0%, 5%, 10%, 20%, >20%), saddle angle (nose down, level, nose up), handlebar height (lower than saddle, higher or even with saddle), and surface cycled (urban streets, rural streets, off road, stationary bike).

Sexual and Urinary Outcome Ascertainment

Participants were queried using validated questionnaires including the Female Sexual Function Index (FSFI) and the American Urological Association Symptom Index (AUA-SI). The AUA-SI was chosen over other measures of urinary dysfunction, such as overactive bladder questionnaires, due to the nature of the exposure (ie, increased perineal pressures) and previous research findings.[6,15] Sexual dysfunction was defined as a total FSFI score less than 27.[16] Significant lower urinary tract symptoms (LUTS) were defined as having moderate symptoms based

Table 1. Demographic characteristics of women cyclist and non-cyclist participants in a multinational cross-sectional survey, 2016

	Total population n = 3,118	Non-cyclists n = 1,053	Low-intensity cyclists n = 1,656	High-intensity cyclists n = 409	*P* value
Age group, y, n (%)					<.001
18–30	1,298 (42)	586 (56)	597 (36)	115 (28)	
31–40	743 (24)	233 (22)	414 (25)	96 (23)	
41–50	563 (18)	126 (12)	339 (20)	98 (24)	
>51	514 (16)	108 (10)	306 (18)	100 (24)	
Race, n (%)					.50
White	2,634 (84)	890 (85)	1,383 (84)	361 (88)	
Black	29 (1)	11 (1)	15 (1)	3 (1)	
Hispanic	179 (6)	58 (5)	100 (6)	21 (5)	
Asian	140 (4)	45 (4)	83 (5)	12 (3)	
Other	136 (4)	49 (5)	75 (5)	12 (3)	
Marital status, n (%)					
Single	1,274 (41)	578 (55)	582 (35)	114 (28)	<.001
Married	1,075 (34)	302 (29)	599 (36)	174 (43)	
Divorced/separated	229 (7)	42 (4)	140 (8)	47 (12)	
Widowed	22 (1)	6 (1)	13 (1)	3 (1)	
Partnered	518 (17)	125 (12)	322 (19)	71 (1)	
BMI, mean (SD)	23.2 (3.8)	23.7 (3.9)	24.2 (3.8)	23.0 (2.9)	<.001
History of diabetes, n (%)					
Yes	27 (1)	7 (1)	19 (1)	1 (0.2)	.15
History of hypertension, n (%)					
Yes	118 (4)	33 (3)	70 (4)	15 (4)	.35
History of ischemic heart disease, n (%)					
Yes	10 (0.3)	5 (0.5)	4 (0.2)	1 (0.2)	.55
Current smoker, n (%)					
Yes	77 (2)	21 (2)	53 (3)	3 (1)	.01
Sexually active, n (%)					
Yes	2,524 (81)	784 (74)	1,388 (84)	352 (86)	<.001

BMI = body mass index.

on the AUA-SI (score greater than 7). Separate scores for urinary filling and voiding symptoms were also calculated using the AUA-SI.[15] Non-validated questions were asked about history of urinary tract infections (UTIs), genital numbness, and genital saddle sores (all self-reported). Saddle sores were defined as any skin symptom/irritation caused by, or exacerbated by, a bicycle seat.

In addition to questions related to our exposures and outcomes, the survey collected information on demographic variables, including age, race/ethnicity, marital status, weight and height; and medical history, including diabetes mellitus, hypertension, ischemic heart disease, and current smoking habits.

Statistical Analysis

Data were analyzed using software (Stata v14, StataCorp, College Station, TX). Demographic and medical variables were compared across athletic groups using Pearson χ^2 test. Univariate and multivariable linear regression were used to evaluate associations between cycling and continuous urinary and sexual outcomes, and logistic regression was used for binomial outcomes. Confounders were chosen a priori for each analysis and included in the multivariable model. The relationship between each continuous potential confounder and each outcome was assessed for linearity before including as a single term in the model. Confounders were selected based on their relationship with cycling intensity and sexual function. In the sexual function analysis, we controlled for urinary symptoms because previous literature has shown urinary dysfunction is associated with sexual dysfunction,[17] and urinary symptoms presumably affect the intensity of cycling. Because the FSFI score can be falsely low in women who are not sexually active, we controlled for sexual activity (yes/no) based on responses from questions 3–14 on the FSFI.[18] All tests were 2-sided and a *P* value of ≤.05 was considered statistically significant. We then performed an exploratory multivariable analysis to determine which cycling characteristics were associated with our outcomes.

RESULTS

In total, 5,853 women participated in the study and 3,118 (53.3%) completed the survey. Of the participants who completed the survey, 1,053 (34%) were non-cyclists, 1,656

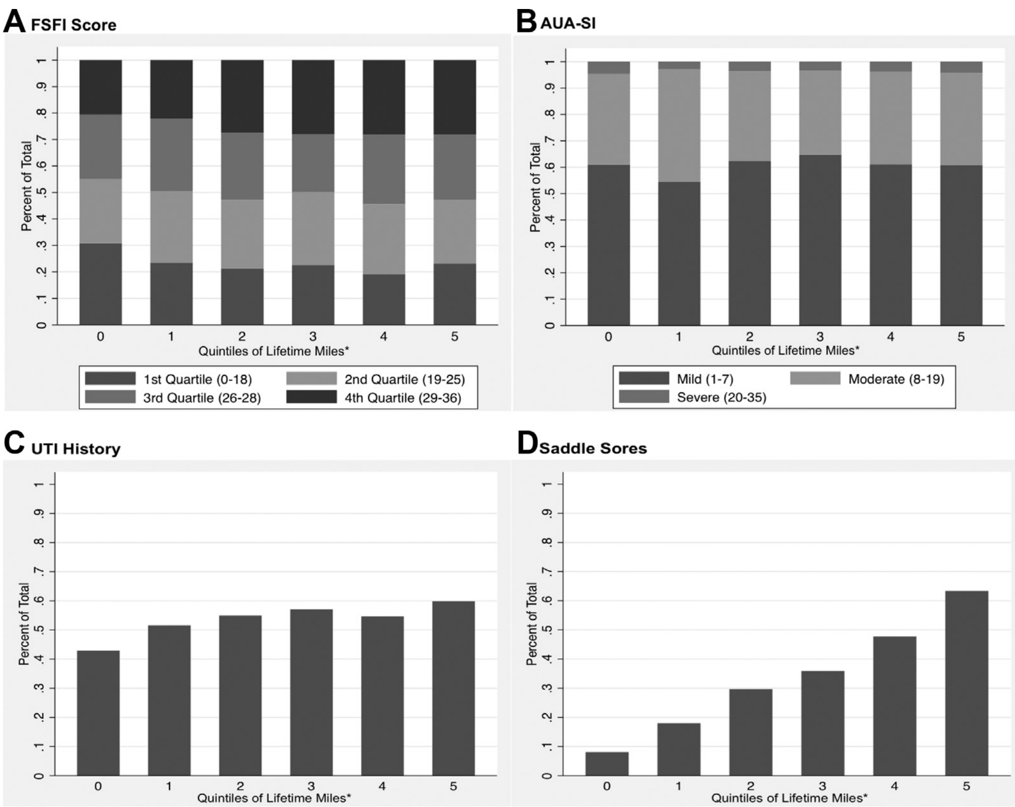

Figure 1. Female Sexual Function Index (FSFI) and American Urological Association Symptom Index (AUA-SI) scores, and prevalence of urinary tract infection (UTI) and saddle sores stratified by quintiles of lifetime miles ridden. A, FSFI (dysfunction cut-off is 27, approximately 50th percentile in our sample). B, AUA-SI. Lifetime history of UTI (C) and saddle sores (D). *Quintiles of lifetime miles: 0 = controls (runners and swimmers); 1 = <6,552; 2 = 6,553–16,720; 3 = 16,721–29,200; 4 = 29,201–65,700; 5 = 65,701–182,500.

(53%) were low-intensity cyclists, and 409 (13%) were high-intensity cyclists. The majority of participants were less than 40 years of age (2,041, 65%), white (85%), single (1,274, 41%), and normal weight (mean body mass index [BMI] 23.2, SD 3.8). Table 1 demonstrates the demographics of our participants stratified by exposure. In general, cyclists were older than non-cyclists and were more likely to have ever been married. Although significant differences in BMI were observed across athletic groups, these differences were not clinically significant. The majority of respondents were sexually active (2,524, 81%). More respondents in the low- and high-intensity cycling groups were sexually active than non-cyclists (84% and 86% vs 74%, respectively). Supplemental Table 1 shows the relative athleticism of swimmers and runners.

The mean FSFI total (SD) and AUA-SI scores of our participants was 22.1 (8.3) and 7.2 (5.6), respectively. Over half of participants reported a history of a UTI (1,602, 51.4%) and met criteria for sexual dysfunction (1,776, 57.0%). Figure 1A shows the quartiles of the FSFI stratified by cycling miles ridden in our sample. Genital numbness (814, 39%) and saddle sores (797, 39%) were commonly reported. The majority of these cyclists felt numbness in their labia/vagina (81%), followed by the buttocks (16%), and perineum (10%). The median level of average numbness (range 1–10) experienced by cyclists was 3 (interquartile range 2–5). The duration of numbness was less than 1 minute, 1–59 minutes, 1–24 hours, and more than 24 hours by 13%, 71%, 14%, and 2%, respectively. In total, 39% of cyclists experienced saddle sores. The majority of saddle sores were in the labia/vagina (53%), followed by the thighs (22%), buttocks (16%), and perineum (9%) (Table 2).

High-intensity cyclists had statistically significantly greater FSFI scores (indicating better sexual function) and a lower odds of reporting sexual dysfunction than non-cyclists. Although no statistically significant differences in AUA-SI scores and LUTS were observed across groups, both low- and high-intensity cyclists had higher odds of reporting a previous UTI, genital numbness, and saddle sores than non-cyclists (Table 3). Similar findings were observed after adjustment for age, BMI, hypertension, diabetes, ischemic heart disease, tobacco use, race, marital status, urinary symptoms, and sexual activity, as appropriate (Table 4). However, we found no statistical differences in FSFI scores between low-intensity cyclists and

Table 2. Genital numbness and saddle sores experienced by women cyclists, n = 2065

Genital numbness	
Ever felt numbness, n (%)	
Yes	814 (39)
Location of numbness, n (%)	
Labia/vagina	661 (81)
Buttocks	127 (16)
Perineum	84 (10)
Other	114 (14)
Average numbness, median (interquartile range)	3 (2–5)
Duration of numbness, n (%)	
<60 s	107 (13)
1–59 min	578 (71)
1–24 h	113 (14)
>24 h	16 (2)
Saddle sores	
Ever experienced saddle sores, n (%)	
Yes	797 (39)
Location of saddle sores, n (%)	
Labia/vagina	424 (53)
Thighs	172 (22)
Buttocks	131 (16)
Perineum	72 (9)
Other	110 (14)

non-cyclists. High-intensity cyclists had a lower odds of reporting sexual dysfunction compared to non-cyclists (adjusted odds ratio 0.7, 95% CI 0.6–0.95, $P = .02$). When we divided cyclists by lifetime number of miles ridden, no differences were observed for sexual and urinary function, whereas a clear dose-response relationship was observed between lifetime miles ridden and reporting a history of saddle sores. A similar dose-response relationship was also observed for reporting a history of UTIs, although the absolute difference across groups was small (Figure 1).

None of the bicycle and road characteristics examined were significantly associated with sexual dysfunction or LUTS (data not shown). Cyclists who reported they never wore padded shorts had lower odds of genital numbness and saddle sores. Standing more than 20% of the time while cycling was associated with non-significantly reduced odds of genital numbness. Off-road biking was associated with a significantly increased odds of saddle sores compared to biking on urban streets. Cycling with a dual padded saddle was positively associated with a reported history of UTI compared to cycling with a wide, unpadded saddle, while standing greater than 20% of the time while cycling was associated with lower odds of reported UTI (Table 5).

DISCUSSION

In an era where cycling has become an increasingly popular modality for exercise, transport, and leisure activity, we sought to explore the association between cycling and female sexual and urinary functions through a comparative cross-sectional survey-based study. To our knowledge, this is the largest study comparing cyclists to other athletes with respect to sexual and urinary function. Contrary to previous studies, we found that cycling did not negatively impact sexual or urinary function. However, cycling was strongly associated with both genital

Table 3. Associations between cycling and urinary and sexual health outcomes among women participants in a multinational cross-sectional survey, 2016

	Non-cyclists n = 1,053	Low-intensity cyclists n = 1,656	P value	High-intensity cyclists n = 409	P value
FSFI domains, mean score					
Desire	3.7 (Referent)	3.8	.29	3.8	.22
Arousal	3.7 (Referent)	4.2	<.001	4.3	<.001
Lubrication	4.0 (Referent)	4.4	<.001	4.5	<.001
Orgasm	3.5 (Referent)	4.1	<.001	4.3	<.001
Satisfaction	4.2 (Referent)	4.4	<.001	4.4	.01
Pain	1.6 (Referent)	1.7	.17	1.7	.19
Mean FSFI total score	20.8 (Referent)	22.6	<.001	23.1	<.001
Sexual dysfunction, OR (95% CI)	1.0 (Referent)	0.8 (0.6–0.9)	<.001	0.6 (0.5–0.8)	<.001
AUA-SI filling symptoms, mean sub-score*	4.6 (Referent)	4.6	.56	4.8	.49
AUA-SI voiding symptoms, mean sub-score†	2.8 (Referent)	2.5	.06	2.4	.05
Total AUA-SI, mean score	7.4 (Referent)	7.1	.16	7.1	.43
LUTS, OR (95% CI)	1.0 (Referent)	1.0 (0.9–1.2)	.98	1.0 (0.8–1.3)	.98
History of UTI, OR (95% CI)	1.0 (Referent)	1.6 (1.4–1.9)	<.001	1.8 (1.5–1.9)	<.001
Perineal numbness, OR (95% CI)	1.0 (Referent)	5.7 (4.5–7.1)	<.001	7.0 (5.3–9.3)	<.001
Saddle sores, OR (95% CI)	1.0 (Referent)	5.8 (4.5–7.5)	<.001	19.5 (14.3–26.5)	<.001

AUA-SI = American Urological Association Symptom Index (higher score indicates worse symptoms); FSFI = Female Sexual Function Index (higher score indicates fewer symptoms); LUTS = lower urinary tract symptoms; OR = odds ratio; UTI = urinary tract infections.
*Questions 2, 4, and 7 of the AUA-SI (sub-score 0–15).
†Questions 1, 3, 5, and 6 of the AUA-SI (sub-score 0–20).

Table 4. Adjusted urinary and sexual health outcomes among women stratified by cycling exposure

	Non-cyclists n = 1,053 (34%)	Low-intensity cyclists n = 1,656 (53%)	P value	High-intensity cyclists n = 409 (13%)	P value
FSFI domains, adjusted mean score†					
Desire	3.7 (Referent)*	3.8*	.55*	3.9*	.10*
Arousal	4.0 (Referent)*	4.1*	.25*	4.1*	.09*
Lubrication	4.3 (Referent)*	4.3*	.64*	4.3*	.68*
Orgasm	3.9 (Referent)*	4.0*	.16*	4.0*	.07*
Satisfaction	4.4 (Referent)*	4.4*	.78*	4.3*	.34*
Pain	1.7 (Referent)*	1.6*	.64*	1.6*	.58*
FSFI total score, adjusted mean score†	22.0 (Referent)*	22.1*	.55*	22.3*	.24*
Sexual dysfunction, aOR (95% CI)†	1.0 (Referent)	0.9 (0.8–1.2)*	.74*	0.7 (0.6–0.95)*	.02*
AUA-SI filling symptoms, mean sub-score‡,§	4.7 (Referent)	4.5	.32	4.8	.55
AUA-SI voiding symptoms, mean sub-score‡,‖	2.7 (Referent)	2.5	.09	2.5	.17
Total AUA-SI, mean score‡	7.4 (Referent)	7.1	.13	7.2	.63
LUTS, aOR (95% CI)‡	1.0 (Referent)	1.0 (0.8–1.2)	.50	1.0 (0.8–1.3)	.84
History of UTI, aOR (95% CI)†	1.0 (Referent)	1.4 (1.2–1.6)*	<.001	1.4 (1.1–1.8)*	.009*
Perineal numbness, aOR (95% CI)†	1.0 (Referent)	6.5 (5.1–8.2)*	<.001	9.1 (6.8–12.4)*	<.001
Saddle sores, aOR (95% CI)†	1.0 (Referent)	6.3 (4.9–8.2)*	<.001	22.7 (16.4–31.4)*	<.001

aOR = adjusted odds ratio; AUA-SI = American Urological Association Symptom Index (higher score indicates worse symptoms); FSFI = Female Sexual Function Index (higher score indicates fewer symptoms); LUTS = lower urinary tract symptoms; UTI = urinary tract infections.
*Adjusted for sexual activity.
†Adjusted for age, body mass index, hypertension, diabetes, ischemic heart disease, tobacco use, urinary symptoms, race, and marital status.
‡Adjusted for age, body mass index, diabetes, tobacco use, history of UTI, race, and marital status.
§Questions 2, 4, and 7 of the AUA-SI (sub-score 0–15).
‖Questions 1, 3, 5, and 6 of the AUA-SI (sub-score 0–20).

numbness and saddle sores, and modestly associated with UTIs. These associations deserve further inquiry. Increasing the time standing out of the saddle was associated with lower odds of self-reported genital numbness.

The association between cycling and genital numbness is well-known, and we further confirmed this finding.[5] Whether genital numbness leads to sexual dysfunction is not well understood. Partin et al[1] reviewed 21 small studies relating cycling characteristics to genital numbness and observed no correlation. However, numbness has been associated with decreased genital sensation (ie, increased vibratory thresholds), as well as dyspareunia and dysuria.[19,20] These studies were limited by small samples sizes and a homogenous group of cyclists; thus, the generalizability is uncertain. In our study, we observed no association between cycling intensity or duration and either sexual or urinary function. These null findings may potentially be explained by the cardiovascular benefits of cycling, which may promote sexual health by improving blood flow.[21] Cyclists were more sexually active than non-cyclists, and thus, the protective effect was attenuated in the adjusted analysis. The prevalence of sexual dysfunction in our study was high among all athletic groups (FSFI score average among sexually active women was 26.5), yet these averages mirror those findings in a nationally representative sample of women in the United States (FSFI score average 27.3–28.5).[22] We did not measure any physiological aspects of sexual dysfunction, such as blood flow to the clitoris or anal manometry. Sub-clinical sexual dysfunction among cyclists has been reported in men with no subjective symptoms.[23] The distance between the ischial tuberosities in a woman's pelvis is typically wider than in men and may decrease tension while on a bicycle seat.

Dysuria and difficulty with urination in women cyclists has been reported in 2 published abstracts.[6] We did not find any association between LUTS and cycling, possibly due to a more heterogeneous group of cyclists without urologic symptoms. The co-occurrence of urinary and sexual dysfunction was not overtly examined in our study. However, a recent review summarized the relationship between urinary incontinence and increased rates of sexual dysfunction.[17] Incontinence was not measured in our study, and whether LUTS is a true confounder or mediator among the relationship between cycling and sexual dysfunction remains to be known. In a post hoc analysis of our data, among women who are sexually active, greater AUA-SI score was associated with lower FSFI scores (−0.09, 95% CI −0.12 to −0.06, $P < .001$). The relationship between urinary symptoms and sexual dysfunction among women merits future research.

In contrast to our null findings that cycling is not associated with sexual dysfunction, we found a dose-response relationship between lifetime miles ridden and the odds of reporting saddle sores. Typical skin lesions in women cyclists include saddle sores, ulcerations, folliculitis, and abscesses.[24] They are thought to be due to vascular and lymphatic compromise from chronic saddle pressures.[25] Hyperplastic labial nodules due to cycling can significantly impact quality of life and may even require surgical

Table 5. Exploratory multivariable analysis of bicycle and road characteristics with sexual and urinary function women participants in a multinational cross-sectional survey, 2016

	aOR for perineal numbness (95% CI)*	*P* value	aOR for saddle sores (95% CI)*	*P* value	aOR for history of UTI (95% CI)*	*P* value
Bike type						
Mountain	Referent		Referent		Referent	
Road	1.3 (0.9–2.1)	.20	1.4 (0.9–2.3)	.15	1.0 (0.7–1.5)	.93
Hybrid	1.0 (0.6–1.6)	.87	1.3 (0.7–2.2)	.38	0.9 (0.6–1.4)	.68
Electric	1.1 (0.1–11.3)	.96	6.6 (0.9–45.6)	.06	0.5 (0.1–3.2)	.45
Folding	1.6 (0.2–13.9)	.68	1.6 (0.2–14.9)	.66	0.7 (0.1–5.3)	.69
Recumbent	1.4 (0.2–10.3)	.74	1.8 (0.2–15.7)	.58	3.1 (0.3–31.3)	.33
Other	1.6 (0.9–2.8)	.12	1.3 (0.7–2.6)	.28	1.0 (0.6–1.7)	.94
Saddle type						
Wide, unpadded	Referent		Referent		Referent	
Long, narrow, with minimal padding	1.2 (0.8–1.9)	.31	0.9 (0.6–1.4)	.68	1.2 (0.8–1.7)	.44
Narrow, medium padded	1.2 (0.8–1.8)	.44	0.7 (0.5–1.1)	.15	1.4 (1.0–2.1)	.07
Wide, heavily padded	0.8 (0.4–1.4)	.40	0.6 (0.3–1.2)	.18	1.2 (0.7–2.0)	.60
Wide, well-padded cruiser	0.5 (0.2–1.0)	.07	0.9 (0.5–1.9)	.88	1.4 (0.8–2.5)	.30
Noseless	3.1 (0.9–10.8)	.07	1.8 (0.5–6.4)	.35	1.2 (0.4–3.7)	.81
Dual pad	2.2 (0.7–6.9)	.20	1.7 (0.5–5.5)	.40	5.6 (1.2–26.2)	.03
Wear padded shorts						
Always	Referent		Referent		Referent	
Mostly	1.1 (0.8–1.4)	.51	0.9 (0.7–1.2)	.66	1.4 (1.1–1.8)	.02
Sometimes	0.8 (0.6–1.1)	.20	0.8 (0.5–1.1)	.18	1.0 (0.8–1.4)	.81
Rarely	0.6 (0.4–0.9)	.03	0.4 (0.3–0.8)	.003	1.2 (0.7–1.8)	.53
Never	0.5 (0.4–0.8)	<.001	0.5 (0.3–0.7)	<.001	1.0 (0.7–1.4)	.93
Time standing						
0%	Referent		Referent		Referent	
5%	0.8 (0.6–1.0)	.08	1.3 (1.0–1.6)	.09	0.8 (0.7–1.1)	.14
10%	0.7 (0.5–0.9)	.02	1.3 (0.9–1.8)	.20	0.8 (0.6–1.0)	.09
20%	0.6 (0.4–1.0)	.06	0.9 (0.6–1.6)	.84	0.8 (0.5–1.2)	.23
>20%	0.5 (0.3–1.0)	.07	1.1 (0.6–2.2)	.69	0.5 (0.3–0.96)	.04
Saddle angle						
Nose down	Referent		Referent		Referent	
Level	0.7 (0.5–1.0)	.05	0.8 (0.6–1.1)	.18	0.9 (0.6–1.2)	.35
Nose up	1.0 (0.5–2.0)	.95	0.6 (0.3–1.2)	.15	1.3 (0.7–2.4)	.47
Handlebar height						
Lower than saddle	Referent		Referent		Referent	
Higher or even with saddle	0.8 (0.7–1.0)	.10	0.8 (0.7–1.0)	.08	1.2 (1.0–1.4)	.11
Surface						
Urban streets	Referent		Referent		Referent	
Rural streets	0.9 (0.7–1.1)	.33	0.9 (0.7–1.2)	.47	0.9 (0.7–1.1)	.14
Off road	1.0 (0.6–1.6)	.95	1.9 (1.1–3.2)	.02	1.0 (0.6–1.5)	.85
Stationary bike	0.7 (0.4–1.2)	.17	0.8 (0.4–1.6)	.57	1.1 (0.6–1.8)	.85

aOR = adjusted odds ratio; UTI = urinary tract infections.
*Adjusted for lifetime cycling miles, age, body mass index, hypertension, diabetes, ischemic heart disease, tobacco use, urinary symptoms, race, and marital status.

excision.[26] In fact, 1 in 5 U.S. women report some degree of vulvar discomfort with sexual activity.[27] Vulvar discomfort is not explicitly measured on the FSFI and could be a cause of sexual dysfunction not measured in our study. We found no differences in FSFI domain for sexual pain; however, the timing of the saddle sore and participating in our study cannot be established. The ideal bicycle seat and cycling positioning to prevent saddle sores is debated.[28] We found no differences in the odds of reporting saddle sores by various seat types in our exploratory analysis. However, adjusting the handlebar higher or even with the saddle or standing while cycling was associated with a non-significantly reduced odds of reporting saddle sores. These handlebar and cycling positions may be recommended for recreational cyclists, but they are less favorable aerodynamically for competitive cyclists.[1] Off-road biking was associated with an increased odds of reporting saddle sores, which may be due to more extreme changes in seat pressure. Undoubtedly, saddle sores present a burden to cyclists and further research is necessary to develop prevention and management strategies.

Little is known about UTIs in women cyclists. In our study, we observed a slight dose-response relationship between the number of lifetime miles ridden and the likelihood of reporting a UTI. This relationship persisted after adjustment in the multivariable analysis. Although the lay literature has numerous articles about preventing UTIs among cyclists, the scientific literature currently does not support this relationship. Dual padded seats were associated with increased odds of reporting a UTI. Given the shorter urethral length in women, increased surface area contact in conjunction with less breathability within the perineum may be a nidus for infection. Due to our cross-sectional design, it is impossible to determine if dual padded seats lead to an increase in UTIs or having recurrent UTIs lead these cyclists to switch to a dual padded seat. These associations in our study may be spurious due to the large number of hypotheses tested or residual confounding factors, and we believe these findings need to be confirmed with future research.

The cycling exposure cut-offs in our study have not been validated. We stratified our exposure in 2 different ways (low vs high intensity per the definitions above) and lifetime miles ridden. We saw a clear dose-response relationship between these variables and expected cycling outcomes, such as saddle sores and genital numbness. The impact of a particular long-distance ride on sexual function was not measured. For example, long-distance riding in men (>250 miles per week) has been associated with temporary erectile dysfunction.[29,30] In our study, only 12 women reported riding more than 50 miles per day, 7 days a week (>350 miles/wk). The median FSFI score in this group is 24.9 (interquartile range 6.6–27). Given the small sample size, these data are difficult to generalize. The results of our study should thus be interpreted within this context.

Our study is limited by its cross-sectional design. Prospective studies are warranted to determine the temporal nature of our observed associations. There might be a response bias; as such the reported prevalence estimates may be biased if survey responders are not representative of non-responders. We do not anticipate, however, that this selection bias is differential with respect to our exposure (cycling) and outcome (urinary and sexual wellness). We only advertised our survey with verbiage and imagery related to exposures and did not include messaging around sexual/urinary dysfunction. In addition, we believe that people who have sexual or urinary dysfunction have stronger incentives for responding to our survey, although this assumption is not validated. Additionally, our recruitment method is subject to survivorship bias, as those who experienced sexual dysfunction due to cycling may have quit before entering into our study. This bias also applies to our bicycle seat analysis, as those who developed saddle sores may be more likely to switch seat type. Prospective studies are necessary, especially among high-intensity cyclists who are sexually active. Some of our outcomes were self-reported (eg, UTIs) and asked through non-validated questions. UTIs were not confirmed by culture or through treatment with antibiotics. However, non-differential misclassification would bias results toward the null. We did not control for additional factors that might confound our results such as frequency of sexual activity. Finally, female sexual dysfunction is defined as a FSFI score below 26.55 combined with distress. As distress was not measured in our survey, our measures more accurately represent risk for female sexual dysfunction and should be interpreted accordingly.

CONCLUSIONS

Contrary to previous reports, we found that women cyclists had no worse sexual or urinary function than non-cyclists. In fact, high-intensity women cyclists had better sexual function than non-cyclists. However, cycling was associated with other genitourinary conditions, including genital numbness, saddle sores, and possibly UTIs. These genital symptoms may lead to sexual dysfunction not measured on the FSFI. Our novel findings for UTIs should be confirmed in future studies. Saddle sores represent a common condition in women cyclists, and future studies on prevention efforts are needed.

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SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jsxm.2018.02.004.